

# Wildlife Services in California: Economic Assessments of Select Benefits and Costs



*Humboldt County*

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## Introduction

In 2003, a study was undertaken to estimate the benefits and costs associated with Wildlife Services (WS) activities in California. The report that resulted from this study, entitled Wildlife Services in California: Economic Assessments of Select Benefits and Costs, provides a comprehensive explanation of the methods used to determine results presented in this document. That extensive report includes detailed descriptions of the sections contained in this document and should be used as a reference to obtain additional information or justification. In addition, an individual report has been prepared for each of the 38 WS participating counties to better delineate these specific economic effects.

To quantify selected benefits and costs of the WS--CA Program we had to determine the benefits and the costs of WS as a complete program. The benefits were derived from multiple information sources, such as replacement programs, National Agricultural Statistics Service (NASS) reports and damages to resources documented in the WS Management Information System (MIS). The benefits of the program were then examined in relation to the costs.

Costs are the cooperative share that each county pays for WS operations. This share represents what is paid at the county level for a WS specialist and is supplemented by funds from the federal government. The percentage paid by the County was larger in 2003 than in previous years as a result of a major cut in state funding. In 2003, the cooperative share for Humbolt County was \$65,350 (USDA, 2003).

The WS program provides a wide array of services. To quantify every one of those services would be difficult, and falls outside the scope of this analysis. Therefore, a survey of California WS district supervisors was undertaken to identify the main wildlife damage concerns in each county. The four general categories used by WS to record wildlife damage management and loss data are: Agriculture, Health and Human Safety, Natural Resources, and Property. The top three specific wildlife damage issues in each category were identified by district supervisors using identical survey forms for all counties. Results showed that the protection of agriculture, particularly sheep, cattle, and goats from predation, was a main agricultural activity of WS personnel operating in the 38 counties contributing cooperative funds. This survey information was used to tailor the economics analysis. That is, the benefits and costs of WS activities relevant to cooperating counties served as the basis for deriving economic impacts of program replacement costs, total wildlife damage, etc. for specific counties.

The data sources used for this report include NASS, United States Bureau of Census (USBC), WS MIS and a survey of Wildlife Services district supervisors.

## **Humbolt County Statistics**

This document is a county-specific report detailing the unique benefits and costs of WS in Humbolt County.

### **County Demographic Statistics**

According to the 2000 U.S. Census, Humbolt County had a total population of 126,518; the total land area of Humbolt County is 3,572 square miles, which translates to a population density of 35.4 people per square mile. In 2000, the population living in urban communities was 87,936 and the population living in rural communities was 38,582; this means that 30.5% of the human population lived in rural county areas. In 2000, per capita income was \$17,203, with 23.0% of the population (25+) reportedly having a bachelor's degree or higher (USBC, 2004).

### **County Agriculture Statistics**

The total number of farms reported in Humbolt County for 2000 was 792. Of 584,538 total acres of farmland, 51,228 acres were cropland in 2000. In the county there were approximately 63,106 total head of cattle, of which 22,333 were beef cows, and 3,601 head of sheep, of which 2,405 were ewes one year and older in 2002 (NASS, 2004). Given that these data are the most accurate and recent data available, those parts of this report that require multi-year analysis will utilize the same 2002 data.

## **Determination of Benefits**

Several steps were taken to identify the benefits associated with WS operations in Humbolt County. The first step was to identify and understand the categories in which services were provided (i.e., Agriculture, Health and Human Safety, Natural Resources and Property). The survey of WS district supervisors was analyzed, and supplemental data were collected from the California WS MIS database for the period 1999 to 2003. WS specialists routinely complete MIS forms to record actions they take in the protection of each county's resources and to record loss data. These two sources were integrated to provide county-specific information. The next step was the selection of the appropriate economic methodology to quantify the monetary value of these services.

The benefits of WS in California were determined using several different economic methods, due to the variety of services provided in each county. First, the benefits of WS were determined using the "replacement value," the cost of a replacement program required en lieu of WS operations. Second, benefits were determined by estimating the economic value of losses in certain sectors of the economy relative to the economy as a whole. In other words, this value would represent the multiplier effects of losses in the agricultural sector throughout the county's economy; this analysis was accomplished by using an economic impact analysis for planning (IMPLAN). Third, the value of WS was also determined by projecting a range of costs that each county would likely experience in the absence of WS (for damage that would likely continue if offending individuals were not removed and technical assistance not provided). Finally, indirect and intangible benefits were described because monetary quantification of such benefits was unrealistic within the scope of this study.

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## Agriculture

Agricultural protection is the largest component of WS operation in a majority of the 38 cooperating counties in California. The survey of district supervisors revealed that the most important concerns for the majority of the counties involved livestock protection. As a result, our focus for the Agricultural section was on the value of livestock protection by WS. For the purpose of this report, livestock includes sheep and cattle only, unless otherwise specified. This section is divided into three main components. The first component details the results of the livestock protection replacement program discussed in the main report. The second component estimates the economic impact of an increase in predation on beef cattle and sheep due to the hypothetical absence of WS activities. The third component provides a discussion of benefits that we are unable to quantify but are still important to consider in the economics analysis.

### A) Replacement Program

The main report provides a detailed analysis of the livestock protection replacement program used for comparison in this section. This livestock protection program is an actual method used in one California county to replace WS livestock protection operations. The trends in the levels of predation, indemnification, participation, production and reimbursements over two years of program operation are provided in the main report, and are utilized to calculate the impacts in Humbolt County in this section. The livestock protection replacement program is divided into two categories: (a) monetary reimbursement for protection improvements to the facility (e.g., fencing, guard dogs, scare devices, etc.) and (b) indemnification: compensation for livestock killed by predators (market price per head lost). Predation rates of 1.5% (year one) and 3.2% (year two) were based on the number of lambs lost to predators in each year and a hypothetical lamb crop of 1.5 lambs/1 ewe. Indemnification costs were based on these levels of predation, and were calculated by multiplying the number of lambs lost to predation by the market price given in the livestock protection replacement program (year one: \$70/head; year two: \$82/head).

Results of the analysis for year one in Humbolt County indicated that of the 2,405 sheep in the county, 69 percent or 1,655 ewes would be included in the replacement program, resulting in an improvement reimbursement payment of \$11,900 (Table 1). At the 1.5% level of predation seen in the comparison livestock protection replacement program, the indemnity payment would have been \$2,606, for a total of \$14,507 in the first year. The national average predation rate of 4% for sheep provided in Table 1 was incorporated into the analysis to provide estimates of indemnity at a rate more commonly experienced by livestock producers elsewhere in the nation (Jones, in press). Results for other replacement scenarios can be interpreted through the same process.

**Table 1: Replacement Program Scenarios for Sheep in Humbolt County**

Yr	Ewes 1 yr + in		Improve. Reimburs.	Indemnity Costs		Total Costs	
	Humbolt	Program		1.5%	4% <sup>a</sup>	1.5%	4% <sup>a</sup>
1	2,405	1,655	\$11,900	\$2,606	\$6,950	\$14,507	\$18,851
				3.2%	4% <sup>a</sup>	3.2%	4% <sup>a</sup>
2	2,405	1,958	\$12,345	\$7,707	\$9,634	\$20,052	\$21,979

<sup>a</sup> National Agriculture Statistics Service

Scenarios for beef cattle are identical to those for sheep except that the amount of indemnity was based on a market value for cattle of \$425 per head, and more conservative predation rates (1.0 and 1.5%) were used to determine indemnity. For the first year, results indicated that for the 15,367 beef cattle included in the program, \$110,507 would be paid in improvement reimbursement and \$65,311 would be paid in indemnity, for a total cost of \$175,818 (Table 2). Results for the second year can be determined in a similar way.

**Table 2: Replacement Program Scenarios for Cattle in Humbolt County**

Beef Cows in						
Year	Humbolt	Program	Improve. Reimb.	Predation	Indemnity	Total
1	22,333	15,367	\$110,507	1.0%	\$65,311	<b>\$175,818</b>
2	22,333	18,184	\$114,632	1.5%	\$115,920	<b>\$230,552</b>

Table 3 displays the total costs for the livestock protection replacement program in Humbolt County for each year at two different levels of predation for sheep and one level of predation for cattle. In year one, at a 1.5% level of predation on sheep and a 1.0% level of predation on cattle, Humbolt County would expend \$190,325 (i.e., \$14,507 sheep + \$175,818 beef) for improvement reimbursement and indemnity for this livestock protection replacement program. In year two, at a 3.2% level of predation for sheep and a 1.5% level of predation for cattle, costs would rise to \$250,604 (i.e., \$20,052 sheep + \$230,552 beef). In 2003, Humbolt paid WS \$65,350 for all services, including a livestock protection program. Thus, it could be argued that the net savings to Humbolt County relative to the livestock protection replacement program would be **\$124,975 to \$185,254**.

**Table 3: Total Costs Associated with Livestock Protection Replacement Program in Humbolt County**

Level of Cattle Predation	Level of Sheep Predation	
	1.5%	4% <sup>a</sup>
<b>1.0% (year 1)</b>	<b>\$190,325</b>	<b>\$194,669</b>
	3.2%	4% <sup>a</sup>
<b>1.5% (year 2)</b>	<b>\$250,604</b>	<b>\$252,531</b>

<sup>a</sup> National Agricultural Statistical Service

## **B) Increased Damages – Impact Analysis for Planning**

For a complete discussion of the Impact Analysis for Planning (IMPLAN) study, see Appendix A. The IMPLAN modeling system estimates the impacts of economic change in a specific sector to other parts of the economy. For the purposes of this analysis, the source of economic change is an increase in predation on sheep and cattle due to the absence of WS. Relevant scientific literature suggests that in the absence of predation management, predation rates would likely increase for both sheep and cattle (Bodenchuk et al., 2002). Lending further support to this argument, the livestock protection replacement program previously described yielded predation rates that conservatively increased 1.7% from year one to year two. Thus, for the IMPLAN analysis, hypothesized increased predation rates for sheep were set as 2% (level 1), 2.5% (level 2), and 3% (level 3); increased predation rates for cattle were set as 1% (level 1), 1.5% (level 2), and 2% (level 3).

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Table 4 projects results of the IMPLAN analysis; note the loss in output and employment as predation increases. For example, a level 2 increase in predation for sheep (2.5%) and cattle (1.5%) results in a loss of output of \$182,795 to the Humboldt County economy and a loss of 8 jobs in the county. These results suggest that an increase in predation on sheep and cattle in the absence of WS activities could result in the loss of **\$123,929 to \$241,663** of output value and 5 to 10 jobs in the county.

**Table 4: IMPLAN Results for Humboldt County**

	Level 1		Level 2		Level 3	
	Output Loss	Loss of Employment	Output Loss	Loss of Employment	Output Loss	Loss of Employment
Sheep	\$ 12,390	1	\$ 15,487	1	\$ 18,585	1
Cattle	\$111,539	5	\$ 167,308	7	\$223,078	10
<b>Total</b>	<b>\$123,929</b>	<b>5</b>	<b>\$ 182,795</b>	<b>8</b>	<b>\$241,663</b>	<b>10</b>

### C) Indirect and Intangible Benefits

Indirect benefits are usually an unintentional side effect of the primary purpose of the WS program, and in some cases are viewed as multiplier effects from direct benefits. For the WS predation management program, the value of these benefits depends on the quantity and variety of species affected by predators. In many cases, the indirect benefit of livestock protection may result in a decrease in predation of other prey species. These may include domestic goats, fowl and exotics or threatened, endangered and game species. Their numbers (and value) may equal or exceed the direct benefit in livestock losses avoided. Additional indirect benefits can accrue to the communities that depend on the livestock industry as a primary source of revenue (these are captured by the IMPLAN analysis).

Intangible benefits exist as a result of the WS program, but are difficult to quantify monetarily. These benefits incorporate factors like increased cooperation from landowners in others areas of service to the county and state as a result of the implementation of a predation management program (e.g., endangered species management actions and land management conservation practices). Additional intangible benefits include possible reductions in the use of less humane or illegal methods to control predators. Wildlife Services specialists are required to conduct all wildlife damage management activities in compliance with applicable federal and state laws and must record all activities for management purposes. The recognition of the importance of intangible benefits in a predation management program is vital to providing an accurate description of the contribution of the program

## Health and Human Safety, Natural Resources, and Property

Protection of resources by WS in Humboldt County also includes health and human safety, natural resources, and property. The economic methods used to calculate benefits for these areas of protection are the same, and so their analysis has been combined into one section for simplicity.

This section is divided into three main elements, each addressing the remaining categories protected by WS. The first element uses the replacement of WS operations by an outside entity to determine the value of WS. The second element estimates the economic impact of

an increase in damage when WS personnel are not present to remove the responsible animals. The third element provides a discussion of indirect and intangible benefits related to WS protection of health and human safety, natural resources, and property.

Regarding health and human safety, the survey of WS district supervisors revealed that the most important concerns in Humboldt County were associated with public safety and wildlife diseases. According to WS MIS data, the most commonly reported damage to general public safety involved threats to humans, injuries/illnesses, droppings and nuisances caused by raccoons, skunks, badgers, mountain lion, opossum, and foxes. Also, MIS data indicated that bird and fish resources were the top natural resource issues in Humboldt County. As far as property damage, the survey listed the most important concerns as damages to general property and buildings by raccoon, bear, and skunk.

#### **A) Replacement Program**

To estimate the cost of replacing the service of capturing and removing animals that pose a health and human safety threat or cause damage to natural resources and property, a range of costs (\$150 to \$200 for most wildlife and \$260 to \$625 for coyotes) was averaged for providers across California. Pricing for service is based upon a single trap setup and removal of one animal (general wildlife mean: \$170, coyote mean: \$395). Conversely, a single damage incident reported by WS personnel may constitute multiple trap locations and the capture of multiple animals. To calculate replacement costs, the number of incidents obtained from the WS-MIS over the five-year period (1999-2003) was multiplied by \$170 in most cases, and by \$395 for coyote incidents, then divided by the number of years to determine mean cost per year. Incidents involving large predators other than coyotes such as mountain lions and bears will be calculated using the mean cost for coyote removal, as the cost for their removal is likely higher. These calculations lead to a very conservative estimate of what WS provides: a cost for the minimum replacement service likely to be performed.

A calculation of the price of a replacement program in the human health and safety sector is provided in Table 5. The replacement costs are calculated over five years of service, to provide an annual mean estimate. To replace WS actions, and thereby protect human health and safety with a similar program, the minimum amount Humboldt County would spend annually would be \$14,552.

**Table 5: Replacement Costs for Health and Human Safety (HHS) Services in Humboldt County (1999-2003)**

	<b>Total No. of HHS Incidents</b>	<b>Total % of HHS Incidents</b>	<b>Replacement Costs</b>
General	428	100	\$72,760
Total	428		\$72,760
<b>Annual</b>	<b>85.6</b>		<b>\$14,552</b>

A calculation of the cost of a replacement program to protect natural resources from wildlife is provided in Table 6. The minimum amount Humboldt County would spend is \$68 annually to replace WS actions in this area.

**Table 6: Replacement Costs for Natural Resource in Humbolt County (1999-2003)**

	Total No. of NR Incidents	Total % of NR Incidents	Replacement Costs
Fish	1	50	\$170
Birds	1	50	\$170
Total	2	100	\$340
<b>Annual</b>	<b>0.4</b>		<b>\$68</b>

In Table 7, the cost of a replacement program to protect property has been calculated. The minimum amount Humbolt County would spend is \$10,335 annually to replace WS actions to protect property.

**Table 7: Replacement Costs for Property in Humbolt County (1999-2003)**

	Total No. of Property Incidents	Total % of Property Incidents	Replacement Costs
Buildings, Non-residential*	9	3	\$2,543
Buildings, Residential	47	16	\$7,990
Food, Non-human	26	9	\$4,420
General	211	71	\$35,870
Turf/Flowers	5	2	\$850
Total	298	101	\$51,673
<b>Annual</b>	<b>59.6</b>		<b>\$10,335</b>

\*Uses a replacement cost of \$282.50 because approx. half of the incidents are due to bears.

## **B) Increased Damages**

A second method to determine the benefit of WS is to estimate the increase in damage to human health and safety, natural resources, and property that residents might experience if WS ceased operations in Humbolt County. The damages caused by wildlife that were incurred by the public were recorded by WS specialists using the MIS reporting system. It is important to note that the WS MIS data base only captures a small portion of the total wildlife damage that occurs in a county during a given year. Certainly many homeowners, ranchers, farmers, etc. simply tolerate or deal with damage on their own and don't report the damage to WS.

Because it is impossible to determine the exact proportional increase in damage if WS were to cease operations, we have projected a range of possibilities. That is, increases of 25, 50 and 100 percent were used to estimate the additional damage. If damage increased 50% in the absence of WS, then we would conclude that WS operations had prevented one-third of the damage likely in the county (Table 8). This means that the benefit of cost sharing for WS operation in this example would be roughly \$188 each year in prevented health and human safety costs to residents.



**Table 8: Estimated Increased Damages to Human Health and Safety in Humboldt County (1999-2003)**

	<b>Total No. of Incidents</b>	<b>Total Damage</b>	<b>Level 1 (25%)</b>	<b>Level 2 (50%)</b>	<b>Level 3 (100%)</b>
General	428	\$1,878	\$470	\$939	\$1,878
Total	428	\$1,878	\$470	\$939	\$1,878
<b>Annual</b>	<b>85.6</b>	<b>\$376</b>	<b>\$94</b>	<b>\$188</b>	<b>\$376</b>

Projected costs for wildlife damage to natural resources in Humboldt County are presented in Table 9. If natural resource damage increased 100% in the absence of WS, then we would conclude that the presence of WS reduces damage by one half. This means the benefit of having this program would be \$154 each year in prevented costs to the public.

**Table 9: Estimated Increased Damages to Natural Resource in Humboldt County (1999-2003)**

	<b>Total No. of NR Incidents</b>	<b>Total Damage</b>	<b>Level 1 (25%)</b>	<b>Level 2 (50%)</b>	<b>Level 3 (100%)</b>
Birds	1	\$20	\$5	\$10	\$20
Fish	1	\$750	\$188	\$375	\$750
Total	2	\$770	\$193	\$385	\$770
<b>Annual</b>	<b>0.4</b>	<b>\$154</b>	<b>\$39</b>	<b>\$77</b>	<b>\$154</b>

To quantify the possible increase in damage to property, a similar range is provided. In Table 10, if property damage increased 100% in the absence of WS, the benefit of having this program would be \$4,851 each year in prevented damage.

**Table 10: Estimated Increased Damages to Property in Humboldt County (1999-2003)**

	<b>Total No. of Incidents</b>	<b>Total Damage</b>	<b>Level 1 (25%)</b>	<b>Level 2 (50%)</b>	<b>Level 3 (100%)</b>
Buildings, Residential	9	\$1,500	\$375	\$750	\$1,500
Buildings, Nonresidential	47	\$2,222	\$556	\$1,111	\$2,222
Food, Non-human	26	\$598	\$150	\$299	\$598
General	211	\$19,629	\$4,907	\$9,815	\$19,629
Turf/Flowers	5	\$305	\$76	\$153	\$305
Total	298	\$24,254	\$6,064	\$12,127	\$24,254
<b>Annual</b>	<b>59.6</b>	<b>\$4,851</b>	<b>\$1,213</b>	<b>\$2,425</b>	<b>\$4,851</b>

### **C) Indirect and Intangible Benefits**

Humboldt County receives a number of indirect and intangible benefits related to human health and safety, natural resource, and property protection as a result of paying cooperative funds for WS activities. Indirect benefits refer to diverse auxiliary benefits from professional and regulatory amenities that federal agencies provide in support of agriculture. Examples include the requirement for WS to comply with National Environmental Policy Act (NEPA)

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regulations in the conduct of wildlife management practices, the training and certification of WS specialists in firearm safety and chemical use and disposal, the participation and support of professionals at the National Wildlife Research Center to provide research and technical support on diverse pesticide registration and use issues, the use of capture methods that adhere to “best management practice” (BMP) guidelines for the removal of animals that come into contact with people, the safe disposal of captured animals using methods that meet current sanitation regulations, and an accurate accounting of program activities via the MIS.

Humboldt County has traditionally reported experiencing a portion of the animal rabies cases that occur in California. The California Department of Health Services (CDHS) “Reported Animal Rabies by County and Species California, 1993-2002” showed that Humboldt County had 51 (1.5%) of the 3,312 animal rabies cases (see <http://www.dhs.ca.gov/ps/dcdc/disb/disbindex.htm>). Of these cases, 9 and 28 involved species of bats and skunks, respectively. Although it would be incorrect to imply that WS is responsible for the control and testing of these potentially rabid animals (CDHS and the California Department of Fish and Game personnel handle these duties), it must be noted that WS does provide technical assistance to residents where threat of rabies is a concern and will remove potential vectors such as skunks and gray foxes. The high level of training provided by WS to its staff goes a long way to ensure that these complaints are dealt with safely and quickly, with the proper referral to other state agencies, if warranted.

## Summary

The current economics analysis for WS activities in Humboldt County demonstrates that multiple returns on invested cooperative dollars were provided to the county. Wildlife damage protection was afforded mainly for agriculture, but protection of human health and safety, natural resources, and property were also areas of operation.

Two general approaches were used to compare expected benefits and costs of this cooperative share payment: replacement costs for WS and assumed increased damage in the absence of WS. For agriculture, estimates of sheep and cattle replacement were derived from empirical predation rates and payments made in a representative California county as well as national predation estimates (Jones, in press). Replacement costs for health and human safety, natural resource, and property protection activities were based upon average fees charged by commercial nuisance wildlife control operators in the state. To determine increased damage estimates in the absence of WS, the IMPLAN analysis used the linkages and multipliers that would occur in the Humboldt County economy due to increased sheep and cattle predation rates of 1.5 to 4%. Additionally, increased health and human safety and property damage values in the absence of WS were based upon assumed 25, 50 and 100% increases in wildlife damage.

Specifically, in order for Humboldt County to employ replacement programs for the agriculture, human health and safety, natural resource, and property protection activities provided by WS, it would cost \$215,280 to \$275,559 (Table 11). Given that Humboldt pays \$65,350 for its WS cooperative share, net annual increased expenses of \$149,930 to \$210,209 would be needed to attain similar benefits afforded by the current approach.

**Table 11: Determination of WS Benefits by Replacement Program for Humboldt County**

	<b>Year 1</b>	<b>Year 2</b>
Livestock Protection Replacement Program	\$190,325	\$250,604
H&HS Replacement Program	\$14,552	\$14,552
Natural Resource Replacement Program	\$68	\$68
Property Replacement Program	\$10,335	\$10,335
<b>Total</b>	<b>\$215,280</b>	<b>\$275,559</b>

Assuming that damage from wildlife would increase 25 to 100 percent in the absence of WS activities within Humboldt County (if the current WS cooperative share were dropped) it was projected that the county would incur between \$125,275 and \$247,044 in additional expenses (Table 12). Under these circumstances Humboldt County would be expected to pay out a minimum of \$59,925 (\$125,275 - \$65,350) or a maximum of \$181,694 (\$247,044 - \$65,350) extra per annum. This range of values represents a significant net savings for Humboldt County.

**Table 12: Damage Estimates in the Absence of Wildlife Services for Humboldt County**

	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>
IMPLAN	\$123,929	\$182,795	\$241,663
Increased H&HS Damages	\$94	\$188	\$376
Increased NR Damages	\$39	\$77	\$154
Increased Property Damages	\$1,213	\$2,425	\$4,851
<b>Total</b>	<b>\$125,275</b>	<b>\$185,485</b>	<b>\$247,044</b>

It is important to understand that it is possible to view all benefits as occurring simultaneously. The WS program achieves certain economies of scale that individual replacement programs do not. This is a result of efficiency gains inherent in WS operations due to the fact that WS can use a broad spectrum of available resources and technology to mitigate wildlife damage problems. We contend that because alternative programs would not have these efficiency gains (e.g., the livestock replacement program) then higher rates of predation and resulting damages would be greater.

For example, in year 1 it would be possible to have replacement programs in place with an associated total cost of \$215,280 and also to have increases in damages and loss to the economy of \$185,485 (level 2), for a grand total of \$400,765 (Table 13). This grand total, minus the sum of cooperative share that Humboldt County pays (\$65,350) could be viewed as a net benefit of \$335,415 to the county as a result of contributing cooperative funds to WS.

**Table 13: Net Benefits of Wildlife Services for Humboldt County**

<b>Costs of Replacement of WS</b>	<b>Year 1</b>	<b>Year 2</b>
<b>Level 1</b>	\$275,205	\$335,484
<b>Level 2</b>	\$335,415	\$395,694
<b>Level 3</b>	\$396,974	\$457,253

# *Estimates of the Economic Impact of Sheep and Cattle Predation on Humboldt County*

**Indirect Economic effects** are generated as livestock predation alters producer purchases of input supplies from other county industries. Money from livestock sales outside the county generates additional economic activity within the county as goods and services are purchased in the livestock production process. The increased or decreased demand for inputs stimulates production from the livestock industry sector within the county. In turn, the livestock industry sector is forced to increase its demand for inputs into its own production process. These indirect economic effects result in additional jobs, increased income for the county and greater tax revenues for community infrastructure development.

The direct and indirect effects resulting from the livestock sector provide for a third kind of effect on the county economy as wage earners, owners or managers spend their earned income and business profits within the county economy. These requirements (demands) placed on the county economy by personal consumption by residents of the county induces additional activity in other sectors of the county economy as residents purchase goods and services for daily living. This is referred to as the **induced effect**.

The total economic impact of the LIVESTOCK SECTOR on the state is a summation of the direct, indirect and induced effects. The indirect and induced effects are often referred to as the **secondary economic effects**. Any increase or decrease in the LIVESTOCK SECTOR output or sales may be expected to cause increases or decreases in secondary economic impacts throughout the remaining county economy.

The magnitude of the secondary effects of the LIVESTOCK SECTOR within the county depends in large part upon:

- whether the LIVESTOCK SECTOR inputs are purchased from within or outside the county, and
- whether the LIVESTOCK SECTOR employees, owners, and managers spend their wages and profits locally.

Clearly, not all the money received from the sale of the LIVESTOCK SECTOR services, and not all income from the LIVESTOCK SECTOR is spent in the county. At each successive cycle of economic activity, some money is lost from the county. Those losses are referred to as “**leakages**” from the county.

Leakages occur for a number of reasons including:

- federal and state taxes that must be paid elsewhere
- the need for specialized equipment and other goods and services that are not available within the county
- consumer preferences for shopping at locations outside the county.

In general, the magnitude of monetary leakage from a county decreases as the degree of economic integration and the availability of goods and services increase locally. As an extremely simplified example, suppose a manufacturer sells a product and receives \$100.00 for it. He saves \$5 in an out-of-county bank, pays \$25 in taxes, and spends the balance of goods and services in the county. The local marketing company is paid \$20, saves \$5 in a local bank, pays \$10 in wages, and buys supplies from some local companies and some out-of-county companies. The employee buys from a local food store that is part of a national chain, etc. As one can see, the issue of leakages from a county can become a complicated issue. Given the nature of Humboldt County, we have made assumptions which decrease the level of leakages.

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The direct effects of predation rates on the LIVESTOCK SECTOR were provided to us. However, estimation of the secondary economic effects of an industry on an economy requires the use of sophisticated computer models. Input-output modeling is an accepted methodology for estimating the secondary effects on an economy. We have used the computer-based model IMPLAN (Impact Analysis for Planning). IMPLAN reflects the 2001 county-level industry activity and the 2001 Bureau of Economic Analysis' accounting of industrial linkages. Further, we have updated the IMPLAN Model to 2003 by a method referred to as ground proofing. This means we have added or deleted firms from each county economy based on current state level economic data on those counties. Data were provided by the State of California.

IMPLAN was used in this study to estimate the economic interrelationships among major business sectors of the county. Since our concern was with total impact of our two different scenarios, we have aggregated the number of economic sectors in our model to the two digit NAICS level. This aggregation reduces the number of sectors in the model significantly, without comprising accuracy. The reader should also note that we did not aggregate the cattle and sheep sectors. This allows us to concentrate on those sectors.

The tables below outline the economic impacts of the county and aggregated models.

**Table 1: County Sheep Impact**

Predation Rate	Output	Employment
2.0%	\$12,390	1
2.5%	\$15,487	1
3.0%	\$18,585	1

**Table 2: County Cattle Impact**

Predation Rate	Output	Employment
1.0%	\$111,539	5
1.5%	\$167,308	7
2.0%	\$223,078	10

**Table 3: Total County Impact**

Predation Rate	Output	Employment
Level 1	\$123,929	5
Level 2	\$182,796	8
Level 3	\$241,663	10